CLAIMS

What is claimed is:

1. An apparatus for illuminating a macroscopically-sized specimen for observation along a viewing axis, the apparatus comprising:

a stage for supporting a specimen to be observed;

a first illumination source of first radiation of a first color;

a second illumination source of second radiation of a second color, different from the first color;

a multiple-end fiber optic cable having at least two input and at least two output ends, receiving the first radiation into a first one of the at least two input ends and receiving the second radiation into a second one of the at least two input ends, producing at each of the at least two output ends both the first radiation and the second radiation so as to illuminate the specimen supported upon the stage so that the specimen may be observed along the viewing axis.

2. The apparatus according to claim 1 wherein the bifurcated fiber optic cable comprises:

a first multiplicity of fiber optic strands receiving the first radiation at the first one of the at least two input ends; and

a second multiplicity of fiber optic strands receiving the first radiation at the second one of the at least two input ends;

wherein the first multiplicity of fiber optic strands is substantially interspersed with the second multiplicity of fiber optic strands within the fiber optic cable, and vice versa, so that the radiation output at each of the at least two output ends of the fiber optic cable is substantially everywhere a combination of the first radiation and the second radiation.

3. The apparatus according to claim 1 used in observing a specimen that is fluorescent in selective regions responsive to both the first radiation and the second radiation, the apparatus further comprising:

a dichroic mirror, located between each of the at least two output ends of the fiber optic cable and the specimen, so that at least some emission of fluorescent radiation induced in the specimen by each of the first radiation and the second radiation will be reflected by the dichroic mirror into an optical path that includes the viewing axis.

4. The apparatus according to claim 1 used in observing a specimen that fluoresces in a third color in selective regions responsively to the first radiation of the first color, the apparatus further comprising:

a first sensor sensing induced fluorescent radiation emission of the third color to produce a first signal; and

a first control circuit, responsive to the first signal, for controlling the first-color first radiation output of the radiation source so that this radiation output is relatively greater when the induced fluorescent radiation emission of the third color is sensed by the first sensor to be relatively less, and is relatively lesser when the induced fluorescent radiation emission of the third color is sensed by the first sensor to be relatively greater.

5. The apparatus according to claim 4 used in observing a specimen that fluoresces in a fourth color in selective regions responsively to the second radiation of the second color, the apparatus further comprising:

a second sensor sensing induced fluorescent radiation emission of the fourth color to produce a second signal; and

a second control circuit, responsive to the second signal, for controlling the second-color second radiation output of the radiation source so that this radiation output is relatively

greater when the induced fluorescent radiation emission of the fourth color is sensed by the second sensor to be relatively less, and is relatively lesser when the induced fluorescent radiation emission of the fourth color is sensed by the second sensor to be relatively greater.

6. The apparatus according to claim 5 further comprising:

a means for adjusting the balance between, on the one hand, the first sensor and first control circuit and, on the other hand, the second sensor and second control circuit, so that the induced fluorescent emission of the third color is of approximately equal intensity to the induced fluorescent emission of the fourth color.

7. The apparatus according to claim 1 wherein the first illumination source comprises:

a first source of radiation of more than just the first color;

a first passband filter, located between the first source of radiation and the first one of the at least two input ends of the fiber optic cable, for passing radiation of the first color from the source of radiation into the first one of the at least two input ends of the fiber optic cable;

and wherein the second illumination source comprises:

a second source of radiation of more than just the second color;

a first passband filter, located between the second source of radiation and the second one of the at least two input ends of the fiber optic cable, for passing radiation of the second color from the source of radiation into the second one of the at least two input ends of the fiber optic cable.

8. The apparatus according to claim 7 wherein the first illumination source comprises:

a neutral density filter between the first source of radiation and the first one of the at least two input ends of the fiber optic

cable.

9. The apparatus according to claim 7 wherein the first illumination source comprises:

an aperture filter between the first source of radiation and the first one of the at least two input ends of the fiber optic cable.

10. The apparatus according to claim 9 wherein the aperture filter comprises:

a selectively occludable aperture within an opaque object, relatively more radiation from the first source of radiation passing to the first one of the at least two ends of the fiber optic cable when the aperture is opened and relatively less radiation from the first source of radiation passing to the first one of the at least two ends of the fiber optic cable when the aperture is closed.

11. A method of illuminating a macroscopically-sized specimen for observation along a viewing axis, the method comprising:

supporting upon stage a specimen to be observed;

first illuminating with first radiation of a first frequency a first one of at least two input ends of a fiber optic cable;

second illuminating with second radiation of a second frequency, different than the first frequency, a second one of at least two input ends of the fiber optic cable; and

producing in at least one output end of the fiber optic cable both the first-frequency first radiation and also the second-frequency second radiation, and illuminating the specimen supported upon the stage with this combined first-frequency first radiation and also the second-frequency second radiation from a single fiber optic cable end so that the specimen can be observed, as illuminated, along the viewing axis.

12. The method according to claim 11 applied to illuminating a specimen that is fluorescent to emit various radiations from various selective regions responsive to both the first radiation and the second radiation, wherein the method further comprises:

reflecting with a dichroic mirror, located between the at lest one output end of the bifurcated fiber optic cable and the specimen, at least some fluorescent radiations that are emitted by the specimen responsively to each of the first radiation and the second radiation into an optical path that includes the viewing axis.

13. The method according to claim 11 applied to illuminating a fluoresces in a first color in selective regions responsively to the first radiation of the first frequency, the method further comprising:

sensing induced fluorescent radiation emission of the first color to produce a signal; and

controlling in response to the signal the first-frequency first radiation so that this first radiation is relatively greater when the induced fluorescent radiation emission of the first color is sensed to be relatively less, and so that this first radiation is relatively lesser when the induced fluorescent radiation emission of the first color is sensed to be relatively greater.

14. The method according to claim 11 further wherein the first illuminating with first radiation of a first frequency the first one of at least two input ends of a fiber optic cable comprises:

producing radiation including radiation of the first and the second frequencies in a radiation source; and

filtering with a first passband filter, located between the radiation source and the first one of the at least two ends of the fiber optic cable, radiation from the radiation source so that radiation of the first frequency is passed into the first one of the at least two input ends of the fiber optic cable;

and wherein the second illuminating with second radiation of a second frequency the a second one of the at least two ends of the fiber optic cable comprises:

filtering with a second passband filter, located between the radiation source and the second one of the at least two ends of the fiber optic cable, radiation from the radiation source so that radiation of the second frequency is passed into the second one of the at least two input ends of the fiber optic cable.

15. The method according to claim 12 wherein at least one of

the first illuminating with first radiation of a first frequency the first one of the at least two input ends of a bifurcated fiber optic cable, and the

the second illuminating with second radiation of a second frequency the second one of the at least two input ends of a bifurcated fiber optic cable,

further comprises:

filtering with a neutral density filter all radiation that is passed into an associated one of the at least two input ends of the bifurcated fiber optic cable.

16. The method according to claim 12 wherein at least one of

the first illuminating with first radiation of a first frequency the first one of the at least two input ends of a bifurcated fiber optic cable, and the

the second illuminating with second radiation of a second frequency the second one of the at least two input ends of a bifurcated fiber optic cable,

further comprises:

filtering with an aperture filter all radiation that is passed into an associated one of the at least two input ends of the bifurcated fiber optic cable.

17. The method according to claim 16 wherein the filtering with an

aperture filter comprises:

selectively occluding with a variable size aperture within a plate radiation passing to an associated input end of the fiber optic cable so that relatively more radiation passes to this associated input end of the fiber optic cable when the aperture is opened, and so that relatively less radiation passes to this associated input end of the fiber optic cable when the aperture is closed.

18. An apparatus for illuminating a macroscopically-sized specimen for observation along a viewing axis, the apparatus comprising:

a stage for supporting a specimen to be observed;

a first illumination source of first radiation of a first color;

a second illumination source of second radiation of a second color, different from the first color;

a fiber optic cable

receiving the first radiation into a first one of two radiation-receiving, or input, ends and receiving the second radiation into a second one of the two radiation-receiving ends, and, responsively to the receiving

producing at each of the at least two radiation-emitting, or output, ends both the first radiation and the second radiation;

wherein a combined, dual-color, radiation produced at each of the at least two radiation-emitting, or output, ends of the fiber optic cable is used to illuminate the specimen supported upon the stage along at least two separate illumination, and viewing, axis.

19. The apparatus according to claim 18 wherein the bifurcated fiber optic cable comprises:

a first multiplicity of fiber optic strands receiving the first radiation at a first one of the two radiation-receiving, or input, ends; and

a second multiplicity of fiber optic strands receiving the

second radiation at a second one of the two radiation-receiving, or input, ends;

wherein the first multiplicity of fiber optic strands is substantially interspersed with the second multiplicity of fiber optic strands at each of the at least two radiation-emitting, or output, ends of the fiber optic cable so that the radiation output at each of these at least two radiation-emitting, or output, ends is substantially everywhere a combination of the first radiation and the second radiation.

20. The apparatus according to claim 18 used in observing a specimen that is fluorescent in selective regions responsive to both the first radiation and the second radiation, the apparatus further comprising:

a dichroic mirror, located between the end of the fiber optic cable and the specimen, so that at least some emission of fluorescent radiation induced in the specimen by each of the first radiation and the second radiation will be reflected by the dichroic mirror into an optical path that includes the viewing axis.

21. A method of illuminating a macroscopically-sized specimen for observation along a viewing axis, the method comprising:

supporting upon stage a specimen to be observed;

first illuminating with first radiation of a first color a first one of two radiation-receiving, or input, ends of the fiber optic cable;

second illuminating with second radiation of a second color, different than the first color, a second one of two radiation-receiving, or input, ends of the fiber optic cable; and

third illuminating with both first-frequency, first radiation, and also second-frequency second radiation, from each of at least two radiation-emitting, or output, ends of the fiber optic cable a specimen supported upon the stage so that the specimen can be

observed, as illuminated, along a single viewing axis.

22. The method according to claim 21 applied to illuminating a specimen that is fluorescent to emit various radiations from various selective regions responsive to both the first radiation and the second radiation, wherein the method further comprises:

reflecting with a dichroic mirror, located between the single end of the bifurcated fiber optic cable and the specimen, at least some fluorescent radiations that are emitted by the specimen responsively to the third illuminating into an optical path that includes the viewing axis.

23. The method according to claim 21 further wherein the first illuminating with first radiation of a first frequency the first one of two radiation-receiving, or input, ends of a fiber optic cable comprises:

producing radiation including radiation of the first and the second color in a radiation source; and

filtering with a first passband filter, located between the radiation source and the first one of the two radiation-receiving, or input, ends of a fiber optic cable, radiation from the radiation source so that radiation of the first color is passed into this first one of the two radiation-receiving, or input, ends of the fiber optic cable; and

filtering with a second passband filter, located between the radiation source and the second one of the two radiation-receiving, or input, ends of a fiber optic cable, radiation from the radiation source so that radiation of the second color is passed into this second one of the two radiation-receiving, or input, ends of the fiber optic cable.

24. An apparatus for illuminating so as to induce fluorescent emissions in each of at least two colors a macroscopically-sized specimen for viewing, the apparatus comprising:

a stage for supporting a specimen to be viewed;

a first illumination source of first radiation sufficient to induce fluorescent emission of a first color in the specimen;

a second illumination source of second radiation sufficient to induce fluorescent emission of a second color in the specimen;

at least one light conduit for delivering both the first radiation from the first illumination source and the second radiation from the second illumination onto the specimen supported upon the stage so that fluorescent emissions in at least two colors are induced in the specimen;

a first sensor sensing induced fluorescent radiation emissions of the first color to produce a first signal;

a second sensor sensing induced fluorescent radiation emissions of the second color to produce a second signal;

a first control circuit, responsive to the first signal, for controlling the first radiation output of the first illumination source so that this first radiation output is relatively greater when the induced fluorescent radiation emission of the first color is sensed by the first sensor to be relatively less, and is relatively lesser when the induced fluorescent radiation emission of the first color is sensed by the first sensor to be relatively greater; and

a second control circuit, responsive to the second signal, for controlling the second radiation output of the second illumination source so that this second radiation output is relatively greater when the induced fluorescent radiation emission of the second color is sensed by the second sensor to be relatively less, and is relatively lesser when the induced fluorescent radiation emission of the second color is sensed by the second sensor to be relatively greater.

25. The apparatus according to claim 24 wherein the at least one light conduit comprises:

a multiple-end fiber optic cable having at least two input and

at least two output ends, receiving the first radiation into a first one of the at least two input ends and receiving the second radiation into a second one of the at least two input ends, producing at each of the at least two output ends both the first radiation and the second radiation so as to illuminate the specimen supported upon the stage.

26. The apparatus according to claim 24 further comprising:

a circuit means for adjusting a balance between the first control circuit and the second control circuit so that induced fluorescent emissions of the first color from the specimen are commensurate in viewed intensity with induced fluorescent emissions of the second color from the specimen.

27. A fiber optic cable having first ends and second ends comprising:

a first and second multiplicity of fiber optic strands all terminating at their one end in a same first one of two radiation-receiving, or input, first ends to the fiber optic cable; and

a third and a fourth multiplicity of fiber optic strands all terminating at their one end in a same second one of the two radiation-receiving, or input, first ends to the fiber optic cable;

wherein the first and the third multiplicity of fiber optic strands all terminate at their opposite end in a same first one of two radiation-emitting, or output, second ends to the fiber optic cable; and

wherein the second and the fourth multiplicity of fiber optic strands all terminate at their opposite end in a same second one of two radiation-emitting, or output, second ends to the fiber optic cable.